Distributed Embedded Fiber Optic Sensor (EFISense) SHM System, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

In Phase I, Redondo Optics Inc. proposes to develop, demonstrate, and deliver to NASA a unique fully integrated, miniature, lightweight, self-powered, wireless communication embedded optical fiber sensor (EFISense®) SHM system suitable for the time-synchronized distributed monitoring of passive and dynamic loads/stress/strains within the strands, rope, and fabric of large and entire cross-sections of NASA®s trailing body deployable decelerator systems such as parachutes and ballutes to provide immediate information to the crew of any detected fault or structural damage within the decelerator representing a valuable safety early warning protection for the crew and space vehicles. The EFISense system is based on the strategic integration of key technologies including the use of distributed array of embedded fiber Bragg gratings sensor weaved within the strands, yarn, and/or fabric of parachutes or ballutes decelerators, and the use of ROI®s proprietary WDM/TDM photonic integrated circuit (PIC) microchip technology that enables the production of a lightweight, compact, and self-power (battery) operation of a multiplex EFISense® transceiver sensor interrogation system. In Phase II, the EFISense SHM system will be engineered into a stand-alone autonomous system and integrated into an airborne ready decelerator prototype system and tested under load environments representative of decelerator decent missions. When developed, the miniature self-power EFISense® SHM system will provide a new and innovative global coverage SHM solution for NASA®s trailing body decelerator technologies as well as other spacecraft systems where size, weight, and power are critical for operation.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: All of NASA's current and future space vehicle programs will benefit significantly from

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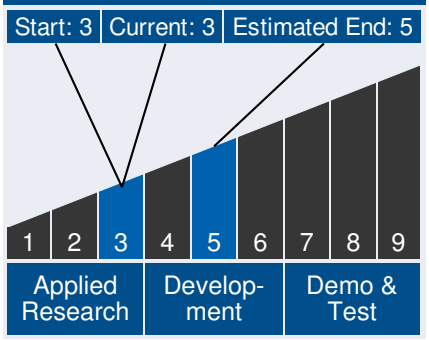
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

this project, wherein the key technological challenge is to develop methodologies for high fidelity monitoring and characterization of load, stress, strain, flaws, fatigue, and degradation in complex built-up structures. NASA's Robotic Exploration Program has a critical need for advanced sensors, sensor systems, sensor techniques, and software that enhances and expands NASA's current SHM capabilities to mitigate the risk of catastrophic failure. Specific NASA applications of the propose EFISense SHM system include un-attended inspections on large and complex composite structures, i.e., decelerator systems parachutes and ballutes, honeycomb structures, multi-wall pressure vessels, thermal blankets, meteoroid shields, batteries, etc., commonly found in spacecraft, and habitats, and support infrastructures.SHM technologies and services provide important day-to-day structural health monitoring inspection and evaluation of a structure. These services contribute to the high level of quality, reliability, and integrity NASA uses for its space vehicles program including spacecraft, and habitats, and support infrastructures. Synthetic material structures continue to find wide aerospace applications due to low weight and high strength requirements. Defects in syntehtic materials can inadvertently be produced either during the manufacturing process, transportation, or in the course of the normal se

To the commercial space industry:

Potential Non-NASA Commercial Applications: The non-destructive test, equipment, and services market generated revenues of $3.77 billion in 2013 with a projection to reach $6.88 billion by 2020, at a CAGR of 8.96% between 2014 and 2020. [1] ROI and its strategic partners expect to capitalize within this market opportunity based on the expected successful development, demonstration, and commercialization of the FAULSense system and to aggressively capture over 5% of the acousto ultrasound monitoring market for aerospace and avionics applications within five years of operations after completion of the Phase II program. This represents a potential business opportunity of over $320 million for ROI and its

Management Team *(cont.)*

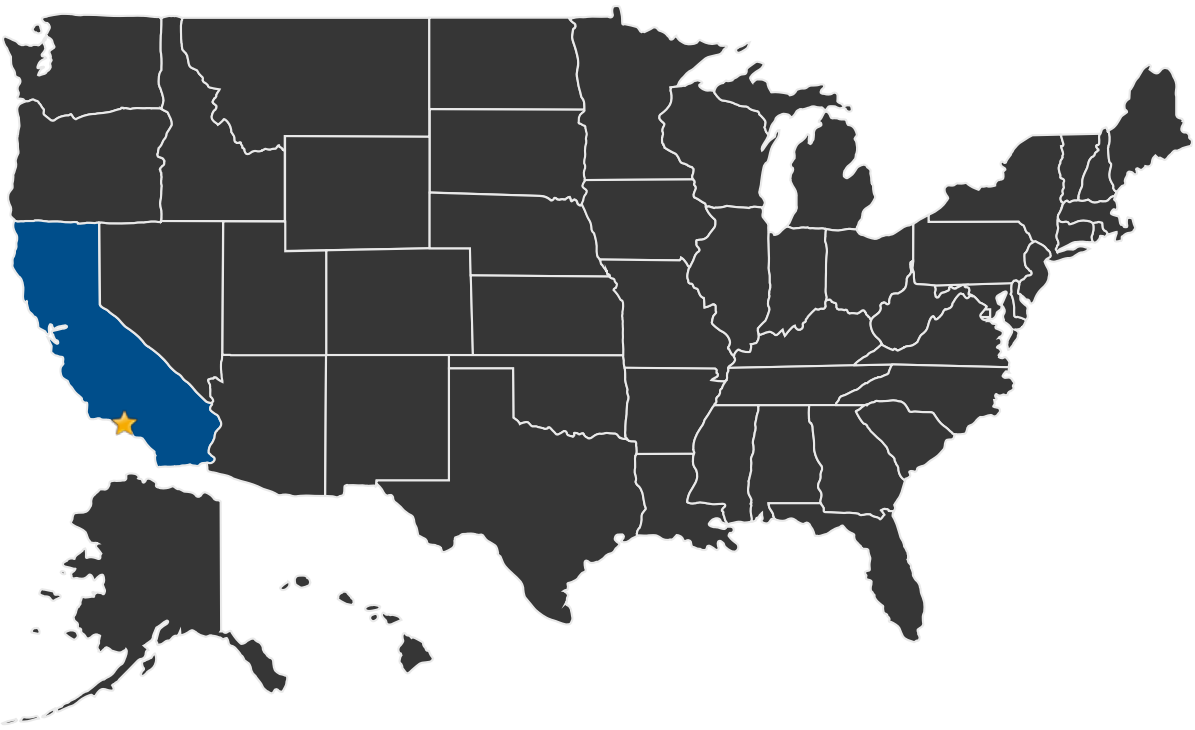
Principal Investigator:
- Edgar Mendoza

Technology Areas

Primary Technology Area:
Entry, Descent, and Landing Systems (TA 9)
- Descent and Targeting (TA 9.2)
  - Trailing Deployable Decelerators (TA 9.2.2)

strategic commercialization partners. Major industries ROI will pursue include the aerospace and aviation industry, oil & gas and petrochemical industries, wind turbines, utilities, coal gas and nuclear power and water treatment plants, automotive, seaports, warehouses, military facilities, airports, civil engineering construction, and healthcare.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

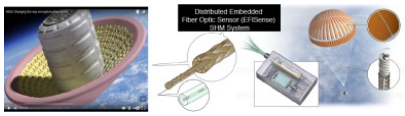
- Redondo Optics, Inc. (Redondo Beach, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23410)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

All of NASA's current and future space vehicle programs will benefit significantly from this project, wherein the key technological challenge is to develop methodologies for high fidelity monitoring and characterization of load, stress, strain, flaws, fatigue, and degradation in complex built-up structures. NASA's Robotic Exploration Program has a critical need for advanced sensors, sensor systems, sensor techniques, and software that enhances and expands NASA's current SHM capabilities to mitigate the risk of catastrophic failure. Specific NASA applications of the propose EFISense SHM system include un-attended inspections on large and complex composite structures, i.e., decelerator systems parachutes and ballutes, honeycomb structures, multi-wall pressure vessels, thermal blankets, meteoroid shields, batteries, etc., commonly found in spacecraft, and habitats, and support infrastructures.SHM technologies and services provide important day-to-day structural health monitoring inspection and evaluation of a structure. These services contribute to the high level of quality, reliability, and integrity NASA uses for its space vehicles program including spacecraft, and habitats, and support infrastructures. Synthetic material structures continue to find wide aerospace applications due to low weight and high strength requirements. Defects in syntehtic materials can inadvertently be produced either during the manufacturing process, transportation, or in the course of the normal se